Received: 7 & 11 September 2015
IOTC–2015–WPEB11–INF11 Rev_1

IOTC Working Party on Ecosystems and Bycatch (WPEB) Olhão, Portugal

07-11 September 2015

A concept note on an IOTC shark tagging programme with pop-up satellite archival tags (PSAT) in response to Indian Ocean Shark Year Programme (ShYP) priorities

Evgeny V. Romanov[(1)*], Rui Coelho[(2)], David Wilson[(3)], Philippe S. Sabarros[(4)], Pascal Bach[(5)]

[(1)] CAP RUN – HYDRÔ RÉUNION, Magasin n°10, Darse de pêche hauturière, Port Ouest, 97420 Le Port, île de la Réunion, France.

[(2)] Portuguese Institute for the Ocean and Atmosphere (IPMA, I.P.). Av. 5 de Outubro s/n, 8700-305 Olhão, Portugal.

[(3)] IOTC Secretariat. Le Chantier Mall (2nd floor), PO Box 1011, Victoria Mahé – Seychelles

[(4)] IRD, UMR 248 MARine Biodiversity, Exploitation & Conservation (MARBEC), Magasin n°10, Darse de pêche hauturière, Port Ouest, 97420 Le Port, Île de la Réunion, France.

[(5)] IRD, UMR 248 MARine Biodiversity, Exploitation & Conservation (MARBEC), Centre de Recherche Halieutique Méditerranéenne et Tropicale, Avenue Jean Monnet, BP 171, CS30171, 34203 Sète Cedex, France.

* Corresponding author, e-mail: evgeny.romanov@ird.fr, Tel : +262 (0) 262 43 66 10, Fax: +262 (0) 262 55 60 10

ABSTRACT

A concept note on shark tagging programme with pop-up satellite archival tags (PSAT) focused on evaluation of shark post-release survival; in particular species banned for retention is presented. Other scientific objectives highlighted in the Indian Ocean Shark Year Programme (ShYP) are considered. Estimated cost of programme evaluated at the level of $US 770,000.

Introduction

Sharks are harvested either by direct targeting or as bycatch in the IOTC area of competence by a variety of fleets and gears, including industrial fleets (purse seine and longline), semi-industrial (drifting gillnets, coastal longline and pole and line), artisanal (gillnets, hand lines) and recreational (sport fishing) (IOTC, 2014; IOTC-IOShYP01, 2014).

"Although diverse, the biological characteristics of these species share some general patterns that make them potentially more susceptible to overfishing than other species, namely because they generally have a low reproductive potential, are slow growing and mature late compared to other species" (IOTC-IOShYP01, 2014). Therefore appropriate conservation measures are necessary to preserve populations of vulnerable, threatened and endangered species in order to preserve biodiversity and ecosystem stability.

Shark caught as unwanted bycatch for many fleets that are discarded dead or released alive. Releasing shark alive has been considered as a robust measure of conservation for several non-targeted species. Furthermore, several IOTC resolutions, in particular resolutions 12/09 and 13/06, prohibit retention of any part of thresher and oceanic whitetip sharks, aiming to promote the release of those species and to support conservation efforts. However, the efficiency of those retention ban policies is still poorly known for many species, due especially to the high level of haul-back mortality for certain species (Coelho et al, 2011) and unknown level of post release mortality.

Tagging with Pop-up Satellite Archival Tags (PSATs) proved to be an expensive but highly efficient tool to estimate post release survival and mortality (both immediate and delayed) for many marine top predators (e.g., Moyes et al., 2006, Skomal, 2007, Musyl, 2015), including sharks (Moyes et al., 2006, Campana et al., 2009b, Musyl et al., 2011; Poisson et al., 2014). In addition to an efficient estimation of the post-release survivorship, PSATs also provide important information on species ecology such as horizontal and vertical movements, habitat use and dial behaviour.

Post-release survival of sharks depends on numerous factors, including fishing gear, handling and releasing practices, shark 'health' state at the moment of release, etc. In the Indian Ocean information on post release mortality of sharks is known for one single species captured in one single gear, notably silky sharks caught in Fish Aggregating Devices (FADs) purse seine fisheries (Poisson et al., 2014). Based on this study, a 'Best practices' guide was developed for release of sharks from purse seine fisheries (Poisson et al., 2012). Some preliminary information using PSATs was obtained also for whale sharks released from purse seine nets (Escalle et al., 2014).

Survival rates of other shark species caught by other fishing gears and released are still unknown. The Indian Ocean Shark Year Program (IO-ShYP) ranked PSAT based studies as **HIGH** priority activity in a short term perspective. Furthermore, there are direct requests of the IOTC Scientific Committee (SC) to the WPEB 'to assess the efficiency of management resolutions on no retention species', which applies directly to bigeye thresher and oceanic whitetip; and in regards to 'post-release mortality of whale sharks in purse-seine fisheries, to assess the efficiency of the best practice currently set in place' (IOTC-SC17, 2014). However, those two requests from the SC cannot be fully addressed without carefully developed PSAT tagging experiments. Other applications of PSAT tagging such as 'Migrations and habitat use' studies are also ranked as **HIGH** priority in the short/medium term in IO ShYP.

Species

Responding to the SC request (IOTC–SC17, 2014), and in conformity with the WPEB considerations reported by the ShYP (IOTC-IOShYP01, 2014) that identified several vulnerable species as high-priority species for research: Shortfin mako shark, *Isurus oxyrinchus*, blue shark *Prionace glauca,* Bigeye thresher shark, Alopias superciliosus, Pelagic thresher shark, *Alopias pelagicus*, oceanic whitetip shark, *Carcharhinus longimanus, and* whale sharks *Rhincodon typus*. Other species of sharks commonly caught in the Indian Ocean tuna fisheries were also considered: silky shark *Carcharhinus falciformis*, and scalloped hammerhead shark *Sphyrna lewini*.

However considering high cost of the program, it was decided to develop post-mortality studies with PSAT tagging in two phases; focusing in the first phase on banned species. Non-retention ban established by the Commission resolutions 12/09 and 13/06 for three species:

Bigeye thresher shark, *Alopias superciliosus*,

Pelagic thresher shark, *Alopias pelagicus*,

Oceanic whitetip shark, *Carcharhinus longimanus*,

Other high priority species should be considered in the second phase (tagging efforts depends on availability of funding) are shortfin mako shark, *Isurus oxyrinchus* (the most vulnerable species on longline fisheries' (IOTC-SC17, 2014) and blue shark *Prionace glauca*.

Silky shark *Carcharhinus falciformis* and scalloped hammerhead shark *Sphyrna lewini*, also mentioned as priority species in the IO ShYP (IOTC-IOShYP01 2014) are considered here as medium priority species.

Post-release mortality study for whale shark, *Rhincodon typus*, taken as bycatch in purse seine fisheries are currently underway (see details below) therefore this species is not considered in this note.

Fisheries

Purse seine fisheries

Major interactions: Known for silky sharks, oceanic whitetip sharks, and whale sharks (Romanov, 2002; Amandè et al., 2012).

Current post-release mortality evaluations are known for silky shark (Poisson et al., 2014) and whale shark (Escalle et al., 2014). The study of Escalle et al. (2014) for whale shark should be considered preliminary, since it is based on a very small sample (4 tags reported data).

SC request: 'Post-release mortality of **whale sharks** in purse-seine fisheries, to assess the efficiency of the best practice currently set in place' (IOTC-SC17, 2014)

SC request: 'Post-release mortality (electronic tagging), to assess the efficiency of management resolutions on no retention species (i.e. oceanic whitetip (OCS) and **threshers sharks**)'.

WPEB11 NOTED that EU institutions AZTI and IRD are currently continue PSAT tagging of whale shark in purse seine fisheries having 10-15 PSAT tags in their possession. Such quantity of PSATs is

considered to be sufficient to estimate efficiency of whale shark handling practice in purse seine gears. Therefore additional efforts in whale shark tagging are not considered.

WPEB11 RECOMMENDED that post release mortality of oceanic whitetip shark released from purse-seine should be considered. Thresher sharks are not taken in the purse sein fisheries therefore these species are not considered for post-release mortality studies for species released form purse seine gear.

Longline fisheries

Major interactions: Known for more than 40 species (Romanov et al., 2010).

No post-release mortality evaluations are known for any Indian Ocean longline fisheries.

SC request: 'Post-release mortality (electronic tagging), to assess the efficiency of management resolutions on no retention species (i.e. **oceanic whitetip** (OCS) and **threshers sharks**) and **shortfin mako** (SMA) the most vulnerable species on longline fisheries' (IOTC-SC17, 2014).

SC request: 'Migration and habitat use, including identification of hotspots and investigate associated environmental conditions affecting the sharks distribution, and making use of conventional and electronic tagging, for **blue** (BSH), **shortfin mako** (SMA) and **oceanic whitetip** (OCS) sharks'

Gillnet fisheries

Major interactions: known for more than 50 species of sharks and rays, including oceanic species under IOTC responsibility (Henderson et al., 2007, Moazzam, 2012).

Not proposed to cover by PSAT study:

- sharks are retained species in most gillnet fisheries, and
- high shark at-haulback mortality in this fishery.

Other fisheries

Not proposed to cover by PSAT study: no major interactions.

Design:

To cover major species of concern: species that are exposed to interaction with main fishing gears used in the Indian Ocean tuna fisheries.

In order to produce post-release mortality estimates that are more representative of the current fisheries, this study **will cover only pure commercial fisheries operations** (Campana et al., 2009a). Therefore, research or specifically designed operations **will not be considered**, as the handling and post-release conditions may be different than what is observed in the commercial operations.

Tagging – principal entities of the program are national research institutions running scientific observer programs onboard tuna fishing fleets in the Indian Ocean. Tagging staff: scientific observers in collaboration with the vessel' crew.

Equipment:

Pop-up Archival Satellite Tags (PSATs)

Complimentary equipment: tagging poles, applicators and field equipment.

PS. Oceanic whitetip shark, *Carcharhinus longimanus* (OCS)

Fleets:

- major PS fleets: European distant water fleets: EU,France, EU,Spain,

Areas: no specific area of preference, but focusing the main areas of the fishing operations of this fleet

Shark handling: shark handling practice during tagging experiments should not be different (except tag placement) from common practice used by particular fleet.

Individual selection: experiment is designed to identify/reproduce common handling practice post-release mortality scenario. The selection of the candidate shark for tagging will be purely randomized with no specific individual selection, except rejection of dead whale sharks (if any), will be applied.

LL. Bigeye thresher shark *Alopias superciliosus* (BTH), pelagic thresher shark *Alopias pelagicus* (PTH), oceanic whitetip shark *Carcharhinus longimanus* (OCS)

Fleets:

- major Asian distant-water fleets: Japan, China (Taiwan),
- major European distant-water and local fleets: EU,France, EU,Portugal, EU,Spain,
- major local fleets: Indonesia

Areas: separate coverage for two major areas of operations:

- Northern area: tropical equatorial area that cover all north Indian ocean north of 15°S
- Southern area: south tropical and temperate area: south from 15°S

Gear / hooks used. For the purpose of this study, it will be considered as uniform gear and hook type pattern within national fleets. However, hook type used by each particular vessel will be noted for each tagging experiment.

Shark handling: shark handling practice during the tagging experiments should not be different (except tag placement) from the common practice used by each particular fleet.

Individual selection:

Random selection: experiment is designed to identify/reproduce common handling practice post-release mortality scenario. The selection of the candidate shark for tagging will be purely randomized with no specific individual selection, except rejection of dead whale sharks (if any), will be applied.

Costs:

Table 1.

Estimated number of tags required by species/fleet for PS oceanic whitetip shark survival study

Species	Fleet	Area of operations	Total
Carcharhinus longimanus	EU,France	Indian Ocean	10
Carcharhinus longimanus	EU,Spain	Indian Ocean	10
Total estimate			**20**

Unit price, including shipment: 4,000$US

Total price of 20 tags: 80,000$US

ARGOS data transmission service: 3,900$US

Tagging equipment (tagging poles, etc…): 2,000$US

Total price: 85,900$US

Table 2.

Estimated number of tags required by species/fleet for LL shark survival study

Phase	Fleet	Area of operations	Total
	Alopias superciliosus		
Phase 1	Japan	Northern	5
		Southern	5
	China (Taiwan)	Northern	5
		Southern	5
	EU, France	Southern	5
	EU, Portugal	Southern	5
	EU, Spain	Southern	5
	Indonesia	Southern	5
	Total		**40**
	Alopias pelagicus		
Phase 1	Japan	Northern	5
		Southern	5
	China (Taiwan)	Northern	5
		Southern	5
	EU, France	Southern	5
	EU, Portugal	Southern	5
	EU, Spain	Southern	5
	Indonesia	Southern	5

Phase	Fleet	Area of operations	Total
	Total		**40**
	Carcharhinus longimanus		
Phase 2	Japan	Northern	5
		Southern	5
	China (Taiwan)	Northern	5
		Southern	5
	EU, France	Southern	5
	EU, Portugal	Southern	5
	EU, Spain	Southern	5
	Indonesia	Southern	5
	Total		**40**
Gross total estimate			**160**

Unit price, including shipment: 4,000$US

Total price of 120 tags: 480,000$US (discount price is possible for batches over 20 tags).

ARGOS data transmission service: 23,400$US

Tagging equipment (tagging poles, etc…): 6,000$US

Total price: ~510,000$US

Funding:

Option 1: Regular budget IOTC.

Options 2. Extra-budgetary funding. Potential funding sources:

- IUCN – International Union for Conservation of Nature,
- WWF - World Wide Fund for Nature,
- ISSF – International Seafood Sustainability Foundation
- Areas Beyond National Jurisdiction Program (ABNJ) – Common Oceans
- CITES and HMS: for CITES and CMS.
- Others…?

References

Amandè, M. J., Chassot, E., Chavance, P., Murua, H., de Molina, A. D., and Bez, N. 2012. Precision in bycatch estimates: the case of tuna purse-seine fisheries in the Indian Ocean. ICES Journal of Marine Science, 69: 1501-1510.

Campana, S. E., Joyce, W., Francis, M. P., and Manning, M. J. 2009a. Comparability of blue shark mortality estimates for the Atlantic and Pacific longline fisheries. Marine Ecology Progress Series, 396: 161-164.

Campana, S. E., Joyce, W., and Manning, M. J. 2009b. Bycatch and discard mortality in commercially caught blue sharks Prionace glauca assessed using archival satellite pop-up tags. Marine Ecology Progress Series, 387: 241-253.

Coelho R., Lino P.G., Santos M.N. 2011. At-haulback mortality of elasmobranchs caught on the Portuguese longline swordfish fishery in the Indian Ocean. IOTC-2011-WPEB07-31.

Escalle L., Chavance P., Amandé J.M., Filmalter J.D., Forget F., Gaertner D., Dagorn L., Mérigot B., 2014. Post-capture survival of whale sharks released from purse seine nets: preliminary results from tagging experiment. SCRS/2014/135. IOTC-2014-WPEB10-INF14.

Henderson, A. C., McIlwain, J. L., Al-Oufi, H. S., and Al-Sheili, S. 2007. The Sultanate of Oman shark fishery: Species composition, seasonality and diversity. Fisheries Research, 86:159-168.

IOTC, 2014. Review of the statistical data available for bycatch species. IOTC Secretariat. IOTC–2014–WPEB10–07 Rev_1. 33 p.

IOTC-IOShYP01 2014. Report of the Indian Ocean Shark Year Program workshop (IO-ShYP01). Olhão, Portugal, 14-16 May 2014. IOTC-2014-IOShYP01-R[E]: 89 pp.

IOTC–SC17 2014. Report of the Seventeenth Session of the IOTC Scientific Committee. Seychelles, 8–12 December 2014. IOTC–2014–SC17–R[E]: 357 pp.

Moazzam M., 2012. Status report on bycatch of tuna gillnet operations in Pakistan. IOTC-2012-WPEB08-13. 12 p.

Moyes, C. D., Fragoso, N., Musyl, M. K., and Brill, R. W. 2006. Predicting postrelease survival in large pelagic fish. Transactions of the American Fisheries Society, 135: 1389-1397.

Musyl, M. K., Brill, R. W., Curran, D. S., Fragoso, N. M., McNaughton, L. M., Nielsen, A., Kikkawa, B. S., Moyes, C D. 2011. Postrelease survival, vertical and horizontal movements, and thermal habitats of five species of pelagic sharks in the central Pacific Ocean. Fishery Bulletin, 109: 341-368.

Musyl, M. K., Moyes, C. D., Brill, R. W., Mourato, B. L., West, A., McNaughton, L. M., Chiang, W.-C., Sun, Ch-L., 2015. Postrelease mortality in istiophorid billfish. Canadian Journal of Fisheries and Aquatic Sciences, 72: 1–19.

Poisson, F., Vernet, A. L., Seret, B., and Dagorn, L. 2012. Good practices to reduce the mortality of sharks and rays caught incidentally by tropical tuna purse seiners. [NP] pp.

Poisson, F., Filmalter, J. D., Vernet, A.-L., and Dagorn, L. 2014. Mortality rate of silky sharks (*Carcharhinus falciformis*) caught in the tropical tuna purse seine fishery in the Indian Ocean. Canadian Journal of Fisheries and Aquatic Sciences, 71: 795-798.

Romanov, E. V. 2002. Bycatch in the tuna purse-seine fisheries of the western Indian Ocean. Fishery Bulletin, 100: 90-105.

Romanov E., Bach P., Rabearisoa N., Rabehagasoa N., Filippi T., Romanova N. 2010. Pelagic elasmobranch diversity and abundance in the Indian Ocean: an analysis of long-term trends from research and fisheries longline data. IOTC-2010-WPEB-16. 19 p.

Skomal, G. B. 2007. Evaluating the physiological and physical consequences of capture on post-release survivorship in large pelagic fishes. Fisheries Management and Ecology, 14: 81-89.